

# NOTES 14: P-VALUES AND SIGNIFICANCE

Stat 120 | Fall 2025

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Last time, we laid out the following steps for setting up a hypothesis test:

1. Formulate hypotheses in terms of *population parameter*
2. Collect data and compute a *sample statistic*
3. Use the *sample statistic* to make a claim about the *hypotheses*

Today, we're diving into step 3:

- 3a. Construct *null distribution*
- 3b. Compute *p-value*
- 3c. Make a decision about  $H_0$

## 0.1 For our study on F's

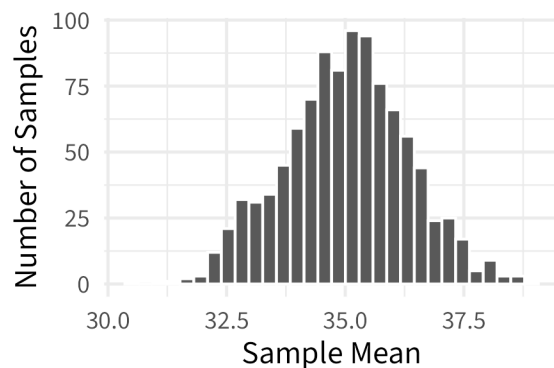
Population parameter:  $\mu$

Sample statistic:  $\bar{x}$

$$H_0 : \mu = 35$$

$$H_A : \mu < 35$$

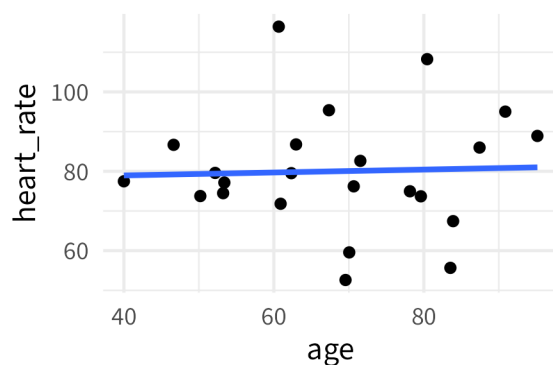
Null Distribution:



**How do we construct a null distribution?**

**StatKey Example:** In a random sample of 765 adults in the United States, 322 say they could not cover a \$400 unexpected expense without borrowing money or going into debt. A journalist claims that this is evidence that the overall proportion could be 50%. Is the journalist justified?

**R “Paper” Example:** A public health researcher believes that there is a positive relationship between heart rate and age among ICU patients. Data from 23 patients gives  $r = 0.037$ .



```
# A tibble: 23 x 2
  age heart_rate
  <dbl>     <dbl>
1  70.7      76.2
2  87.4      86.0
3  67.3      95.4
4  80.4     108.
5  95.1      88.9
6  60.7     116.
7  83.9      67.4
8  79.6      73.7
9  90.9      95.0
10 62.3      79.5
# i 13 more rows
```

```
library(CarletonStats)
permTestCor(heart_rate ~ age, data = icu, alternative = "greater")
```

```
** Permutation test **
```

```
Permutation test with alternative: greater
Observed correlation between age , heart_rate : 0.037
Mean of permutation distribution: -0.00652
Standard error of permutation distribution: 0.2069
P-value: 0.413
```

```
*-----*
```



**R Example:** In a pre-Musk Pew Research Poll on social media use, 72% of Twitter users ( $n = 346$ ) responded that they visited Twitter a few times a week or more. Among Instagram users ( $n = 530$ ), this number was 80%. Is there a difference in frequency of use between Twitter and Instagram users?

```
permTest(visits ~ app, data = social_media)
```

**\*\* Permutation test \*\***

Permutation test with alternative: two.sided

Observed statistic

instagram : 0.8    twitter : 0.7197

Observed difference: 0.08035

Mean of permutation distribution: -0.00025

Standard error of permutation distribution: 0.02929

P-value: 0.004

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# 1 Statistical Significance

Significance Level

Statistical Significance

Formal Statistical Decisions

## 2 Summary

Whenever performing a hypothesis test, you should:

- (1) Perform an appropriate EDA
- (2) Formulate  $H_0$  and  $H_A$
- (3) Compute a *test statistic*
- (4) Construct a *null distribution*
- (5) Compare the test statistic to the null distribution and compute a *p-value*
- (6) Make a decision (reject or fail to reject) about  $H_0$
- (7) Report your conclusion in context